Claims

1. A process for preparing hydrogenated condensed Palatinose, comprising the catalytic hydrogenation of a solution comprising condensed Palatinose.

2. The process of claim 1, comprising the hydrogenation of condensed Palatinose obtainable by heat-treating an aqueous Palatinose solution having a pH of 3 to 6 at a temperature of 100°C to 170°C under atmospheric pressure or reduced pressure.

3. The process of claim 2, wherein the aqueous Palatinose solution to be condensed is prepared by dissolving Palatinose in water.

4. The process of claim 2 or 3, wherein acidic catalysts are added to the aqueous Palatinose solution.

5. The process of claim 4, wherein acidic catalysts added are H^+-loaded, strongly acidic cation exchangers, organic acids, boric acid, a combination of phosphoric acid with potassium dihydrogen phosphate or ammonium sulfate.

6. The process of claim 5, wherein the organic acids are selected from the group consisting of citric acid, malic acid, succinic acid and tartaric acid.

7. The process of any one of claims 2 to 6, wherein condensed Palatinose is obtainable by heat-treating an aqueous Palatinose solution in the presence of 0.02% by weight citric acid, based on Palatinose, in vacuo at a temperature of 135°C.

8. The process of claim 7, wherein the condensed Palatinose comprises about 48% uncondensed Palatinose, about 28% Palatinose dimers, about 12% Palatinose trimers, about 5% Palatinose tetramers, about 5% Palatinose pentamers, and about 2% hydrolysis products.

9. The process of claim 1, comprising hydrogenating condensed Palatinose obtainable by reacting Palatinose with anhydrous hydrofluoric acid at a temperature of 0°C to 20°C.

10. The process of claim 9, wherein the condensed Palatinose comprises about 73% to 94% Palatinose dimers.

11. The process of claim 1, comprising hydrogenating condensed Palatinose obtainable from a Palatinose melt by adding Palatinose to a solution of a catalytically active, acidic substance in water and heating the mixture at a temperature of 130°C to 160°C.

12. The process of claim 11, wherein the mixture comprises 4% to 12% by weight water and 0.05% to 0.5% by weight acidic substance.

13. The process of claim 11 or 12, wherein the acidic substance is an H^+-loaded, strongly acidic cation exchanger, an organic acid, boric acid, a combination of phosphoric acid with potassium dihydrogen phosphate or ammonium sulfate.

14. The process of claim 13, wherein the organic acid is citric acid.

15. The process of any one of claims 11 to 14, wherein the condensed Palatinose comprises 15% to 45% by weight uncondensed Palatinose, 35% to 60% by weight Palatinose dimers, less than 10% by weight Palatinose trimers, and less

than 5% by weight Palatinose tetramers and Palatinose pentamers.

16. The process of any one of claims 2 to 15, wherein the fraction of uncondensed Palatinose in the condensed Palatinose for hydrogenation is reduced by depletion.

17. The process of claim 16, wherein the uncondensed Palatinose is depleted by means of chromatographic separation of the uncondensed Palatinose from condensed Palatinose.

18. The process of any one of claims 1 to 17, wherein the catalytic hydrogenation of the solution comprising condensed Palatinose takes place at elevated temperature under increased pressure in the presence of hydrogen and using a catalyst.

19. The process of claim 18, wherein the solution comprising condensed Palatinose is adjusted to a pH of 6 to 8 prior to hydrogenation.

20. The process of claim 19, wherein the pH of the solution comprising condensed Palatinose is adjusted to 7.8 by adding aqueous sodium hydroxide solution.

21. The process of any one of claims 18 to 20, wherein the hydrogenation takes place at a temperature of 40°C to 140°C.

22. The process of claim 21, wherein the hydrogenation takes place at a temperature of 60°C to 80°C.

23. The process of claim 22, wherein the hydrogenation takes place at a temperature of 70°C.

24. The process of any one of claims 18 to 23, wherein the hydrogenation takes place at a pressure of 50 to 230 bar.

25. The process of claim 24, wherein the pressure is 100 to 200 bar.

26. The process of claim 25, wherein the pressure is 150 bar.

27. The process of any one of claims 18 to 26, wherein the catalyst comprises a mixture of a pure Raney metal and a Raney metal alloy.

28. The process of claim 27, wherein the Raney metal is nickel, copper, cobalt or iron.

29. The process of claim 27, wherein the Raney metal alloy is an alloy of nickel, copper, cobalt or iron with aluminum, tin or silicon.

30. The process of any one of claims 18 to 26, wherein the catalyst comprises as active component one or more metals from transition group VIII of the periodic table on a support.

31. The process of claim 30, wherein the active component comprises ruthenium, palladium and/or rhodium.

32. The process of claim 30 or 31, wherein the catalyst support comprises activated carbon, aluminum oxide, zirconium oxide and/or titanium dioxide.

33. The process of any one of claims 18 to 32, wherein the hydrogenation takes place with stirring.

34. The process of any one of claims 18 to 33, wherein the hydrogenation takes place over a period of at least 2 to 5 hours.

35. The process of claim 34, wherein the hydrogenation takes place over a period of at least 4 hours.

36. The process of any one of claims 18 to 35, wherein the hydrogenation takes place continuously, semibatchwise or batchwise.

37. The process of any one of claims 18 to 36, wherein the hydrogenation is carried out in a fixed-bed process or suspension process.

38. The process of any one of claims 1 to 37, wherein, following hydrogenation of the solution comprising condensed Palatinose, a product mixture is obtained that comprises 25% to 36% by weight hydrogenated condensed Palatinose having a DP of 4, 9% to 15% by weight hydrogenated condensed Palatinose having a DP of 6, 3% to 7% by weight hydrogenated condensed Palatinose having a DP of 8, 3% to 7% by weight hydrogenated condensed Palatinose having a DP of 10, 3% to 7% by weight unhydrogenated condensed Palatinose, and 40% to 55% by weight hydrogenated uncondensed Palatinose.

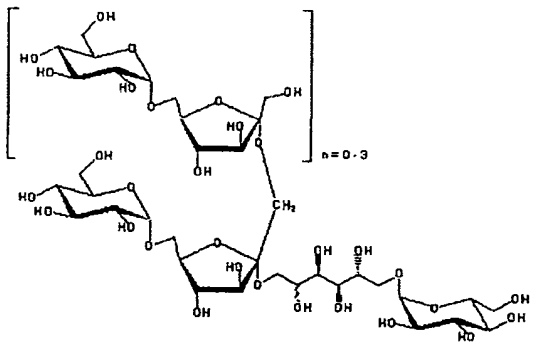
39. The process of any one of claims 1 to 38, wherein, following hydrogenation, hydrogenated condensed Palatinose having a DP of 4 to 10 is separated from the reaction mixture.

40. The process of claim 39, wherein hydrogenated condensed Palatinose having a DP of 4 to 10 is separated from the reaction mixture by means of chromatography.

41. The process of claim 39 and 40, wherein the hydrogenated condensed Palatinose, following separation from the reaction mixture, comprises 30% to 55% by weight hydrogenated condensed Palatinose having a DP of 4, 20% to 30% by weight hydrogenated condensed Palatinose having a DP of 6, 7% to 13% by weight hydrogenated condensed Palatinose having a DP of 8, and 2% to 6% by weight hydrogenated condensed Palatinose having a DP of 10.

42. A hydrogenated condensed Palatinose obtainable by hydrogenating condensed Palatinose according to any one of the processes of any one of claims 1 to 39, comprising at least hydrogenated condensed Palatinose having a DP of 4, hydrogenated condensed Palatinose having a DP of 6, hydrogenated condensed Palatinose having a DP of 8, and hydrogenated condensed Palatinose having a DP of 10.

43. The hydrogenated condensed Palatinose of claim 42, comprising at least one compound of the formula (1)



1

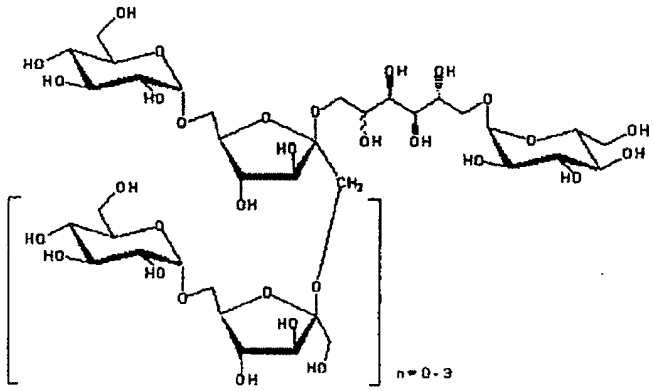
obtainable from α-2→1-linked di-Palatinose, for n = 0 (DP 4):

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→1)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→1)-O-[α-D-glucopyranosyl-(1→6)]-D-mannitol;

at least one compound of the formula (2)



2

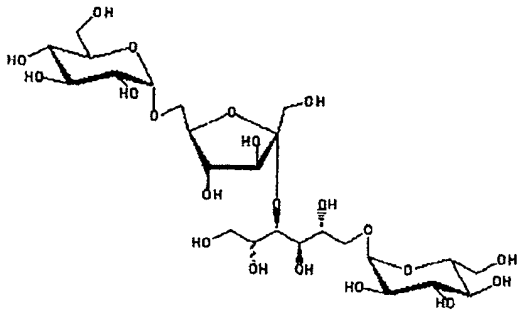
obtainable from β-2→1-linked di-Palatinose for n = 0 (DP 4):

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→1)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→1)-O-[α-D-glucopyranosyl-(1→6)]-D-mannitol;

at least one compound of the formula (3)



3

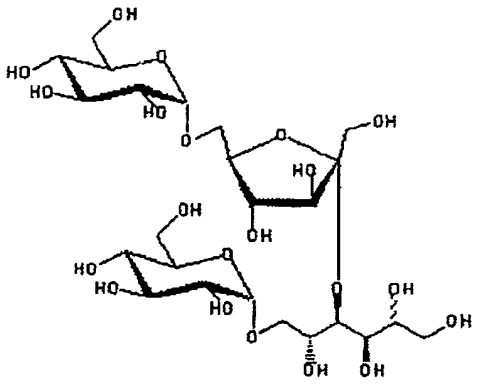
obtainable from α-2→3-linked di-Palatinose:

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→3)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→4)-O-[α-D-glucopyranosyl-(1→1)]-D-mannitol;

at least one compound of the formula (4)



4

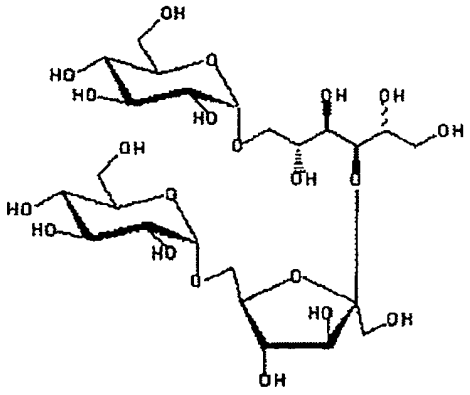
obtainable from α-2→4-linked di-Palatinose:

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→4)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-α-D-fructofuranosyl-(2→3)-O-[α-D-glucopyranosyl-(1→1)]-D-mannitol;

at least one compound of the formula (5)



5

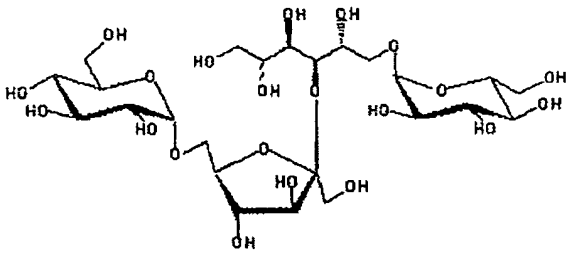
obtainable from β-2→3-linked di-Palatinose:

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→3)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→4)-O-[α-D-glucopyranosyl-(1→1)]-D-mannitol;

and at least one compound of the formula (6)



6

obtainable from β-2→4-linked di-Palatinose:

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→4)-O-[α-D-glucopyranosyl-(1→6)]-D-sorbitol

and

O-α-D-glucopyranosyl-(1→6)-β-D-fructofuranosyl-(2→3)-O-[α-D-glucopyranosyl-(1→1)]-D-mannitol.

44. The hydrogenated condensed Palatinose of claim 42 or 43, wherein the fraction of hydrogenated condensed Palatinose having a DP of 4 is 30% to 55% by weight, the fraction of hydrogenated condensed Palatinose having a DP of 6 is 20% to 30% by weight, the fraction of hydrogenated condensed Palatinose having a DP of 8 is 7% to 13% by weight, and the fraction of hydrogenated condensed Palatinose having a DP of 10 is 2% to 6% by weight.

45. The hydrogenated condensed Palatinose of any one of claims 42 to 44, wherein the fraction of hydrogenated condensed Palatinose having a DP of 4 is 35% to 50% by weight.

46. The hydrogenated condensed Palatinose of any one of claims 42 to 45, wherein the fraction of hydrogenated condensed Palatinose having a DP of 6 is 22% to 28% by weight.

47. The hydrogenated condensed Palatinose of any one of claims 42 to 46, wherein the fraction of hydrogenated condensed Palatinose having a DP of 8 is 8% to 12% by weight.

48. The hydrogenated condensed Palatinose of any one of claims 42 to 47, wherein the fraction of hydrogenated condensed Palatinose having a DP of 10 is 3% to 5% by weight.

49. The hydrogenated condensed Palatinose of any one of claims 42 to 48, further comprising 6% to 12% by weight unhydrogenated condensed Palatinose having a DP of 4.

50. The hydrogenated condensed Palatinose of any one of claims 42 to 49, which is resistant or virtually resistant to breakdown in the mammalian stomach and/or by the enzymes of the mammalian digestive tract.

51. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as an active substance for the prophylaxis and/or treatment of diseases caused by oxidative stress.

52. The use of claim 51, wherein said diseases are cancer illnesses, diabetes I and II, hypertension, stroke, male infertility, rheumatic illnesses, coronary artery illnesses, acute myocardial infarction, and chronic inflammatory diseases.

53. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as an active substance for strengthening

the immune defense against general infections.

54. The use of any one of claims 51 to 53, wherein hydrogenated condensed Palatinose is administered in a dose sufficient to cure the state of a disease caused by oxidative stress, or an infection, or to prevent said disease or infection, to arrest the progress of the disease and/or to alleviate the symptoms of the disease.

55. The use of any one of claims 51 to 54, wherein hydrogenated condensed Palatinose is administered in the form of a pharmaceutical composition, in particular in the form of a suspension, syrup, tablet, pill, capsule, granules or powder.

56. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as a pharmaceutical carrier in a pharmaceutical composition.

57. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 for preparing a pharmaceutical composition for the prophylaxis and/or treatment of diseases caused by oxidative stress.

58. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 for preparing a pharmaceutical composition for strengthening the immune defense against general infections.

59. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as an addition to a foodstuff or drink intended for human consumption.

60. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as soluble fiber, especially as prebiotic

fiber, in foodstuffs or drinks.

61. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 for modulating the glycemic properties of foodstuffs or confectionery, especially for specialty nutrition, infant nutrition or nutrition of persons with defects in glucose/insulin metabolism.

62. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 as a sweetener.

63. The use of hydrogenated condensed Palatinose of any one of claims 42 to 50 for preparing foodstuffs, confectionery, and animal feedstuffs.

64. The use of claim 63, wherein hydrogenated condensed Palatinose is used for preparing acidic foodstuffs having a pH of 2 to 5, especially 2 to 4.

65. The use of claim 63 or 64, wherein hydrogenated condensed Palatinose is used for preparing fruit juices or fruit preparations.

66. A composition comprising hydrogenated condensed Palatinose of any one of claims 42 and 50 and cultures of Bifidobacteria.

67. A composition comprising hydrogenated condensed Palatinose of any one of claims 42 to 50 and at least one further form of fiber selected from the group consisting of short-chain fructo-oligosaccharides, long-chain fructo-oligosaccharides, galacto-oligosaccharides, hydrolyzed guar gum, lactulose, xylo-oligosaccharides, lactosucrose, malto-oligosaccharides, isomalto-oligosaccharides, gentio-oligosaccharides, glucosyl sucrose, soybean oligosaccharides,

chito-oligosaccharides, chitosan oligosaccharides, resistant starch, oat fiber, wheat fiber, vegetable fiber, fruit fiber, celluloses, and sugar beet fiber.

68. A foodstuff of any kind comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

69. The foodstuff of claim 68, wherein the foodstuff in question comprises dairy products and milk products.

70. The foodstuff of claim 69, wherein the dairy products and milk products are cheese, butter, yogurt, kefir, quark, sour milk, buttermilk, cream, condensed milk, dry milk, whey, lactose, milk protein, milk mixture, half-fat milk, whey mixture, and milk fat products.

71. The foodstuff of claim 68, wherein the food in question comprises bakery products.

72. The foodstuff of claim 71, wherein the bakery products comprise bread, including cookies, and fine bakery products, including nonperishable bakery products.

73. The foodstuff of claim 68, wherein the foodstuff in question comprises spreads for bread.

74. The foodstuff of claim 68, wherein the foodstuff in question comprises margarine products and cooking fats.

75. The foodstuff of claim 68, wherein the foodstuff in question comprises instant products and stock products.

76. The foodstuff of claim 68, wherein the foodstuff in question comprises fruit products.

77. The foodstuff of claims 76, wherein the foodstuff in question comprises marmalades, jams, jellies, fruit conserves, fruit pulps, fruit juices, fruit juice concentrates, fruit nectar, and fruit powders.

78. The foodstuff of claim 68, wherein the foodstuff in question comprises vegetable products.

79. The foodstuff of claim 78, wherein the foodstuff in question comprises vegetable conserves, vegetable juices, and vegetable pulp.

80. The foodstuff of claim 68, wherein the foodstuff in question comprises spice mixtures.

81. The foodstuff of claim 68, wherein the foodstuff in question comprises nonalcoholic beverages, beverage base materials, and beverage powders.

82. The foodstuff of any one of claims 68 to 81, which is a reduced-calorie foodstuff.

83. A confectionery product comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

84. The confectionery product of claim 83, wherein said product comprises chocolate, hard caramels, soft caramels, fondant products, jelly products, licorices, marshmallow products, desiccated coconut, coated chocolate candies, compressed candy products, candied fruits, cracknel, nougat products, ice confections, marzipan, chewing gum, muesli bars, and also ice cream or alcoholic and nonalcoholic sweet drinks.

85. The confectionery product of claim 83 or 84, wherein said product comprises reduced-calorie confectionery products.

86. A dietetic specialty food, especially for the nutrition of persons having glucose intolerance, comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

87. An infant food, comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

88. A sweetener comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

89. A pharmaceutical composition comprising hydrogenated condensed Palatinose of any one of claims 42 to 50.

90. The pharmaceutical composition of claim 89, comprising hydrogenated condensed Palatinose as active substance.

91. The pharmaceutical composition of claim 89, comprising hydrogenated condensed Palatinose as pharmaceutical carrier.